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June 1965 ARS 33-106

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Evaluation of Some Experimental Phosphorus and Carbamate Compounds as Systemic Insecticides

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As part of a continuing program to develop systemic insecticides for cotton insect control, several experimental compounds, which appeared promising in preliminary seed treatment tests, were evaluated further as systemic insecticides applied by different methods.

Materials and Methods

The experimental compounds evaluated and their chemical names are as follows:

Company and Designation	Chemical name
American Cyanamid Co.	
CL-47031	Cyclic ethylene (diethoxyphosphinyl)=dithioimidocarbonate
Bayer, A. G.	
Bayer 30237	O-methyl O-[p-(methylthio)phenyl] methylphosphonothioate
Bayer 30554	O-methyl O-[p-(methylsulfinyl)=phenyl] methylphosphonothioate
Niagara Chemical Div.	
NIA-10242	2,3-dihydro-2,2-dimethyl-7-benzofuranyl methylcarbamate
Union Carbide Corp.	
UC-21149	2-methyl-2-(methylthio)=propionaldehyde O-(methylcarbamoyl)=oxime

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[1] In cooperation with the Texas Agricultural Experiment Station, Texas A & M University. The technical assistance of S. L. Jones of this Division is gratefully acknowledged.

Phorate was included as a standard in most of the tests. However, CL-47031 could also be considered a standard because of its outstanding control of insects through systemic action in previous tests [(1) and (3)][2]

The following application methods were used in evaluating the experimental compounds: (1) Topical application, (2) stem application to cotton plants, (3) application of granules in the seed furrow at planting, (4) granules sidedressed to cotton in the greenhouse, and (5) granules sidedressed to cotton in the field. For statistical analysis of data, a factorial analysis of variance and Duncan's multiple range test were used for all data except the topical application data, for which probit analysis was used.

Laboratory-reared insects and mites were used to bioassay leaves of treated plants and included the boll weevil *Anthonomus grandis* Boheman, the cotton aphid *Aphis gossypii* Glover, and the carmine mite *Tetranychus cinnabarinus* (Boisduval). The bioassay technique was similar to that reported by Ridgway et al. (2).

The toxicity of topical applications of acetone solutions of the various toxicants to adult boll weevils was determined by applying the desired amount of toxicant to the thorax in 1 µl. of acetone. After treatment, weevils were fed cotton squares and held at a temperature of 80±5°F for 72 hours before mortality counts were made. A minimum of 400 insects were treated with each experimental compound. The average weight of treated insects was approximately 14 mg.

In the stem applications, 2 mg. of active ingredient of each compound was applied in a 2-percent lanolin paste to plants in the 6- to 8-leaf stage. The lanolin paste was applied in a band 2 inches wide around the main stem of the plants, approximately 2 inches from the soil level. The treatments and an untreated check were replicated four times, and were arranged in a completely random design.

The application of granules at planting was accomplished with a modified belt seeder. One lb. of active ingredient, formulated as 10-percent granules, was applied in the furrow with the seed in single-row plots, 10 ft. long. The treatments and an untreated check were replicated three times, and were arranged in a completely random design.

The sidedress applications of granules in the greenhouse were made to individual plants, at the 6-true-leaf stage, growing in 1 gallon containers. The compounds, formulated as 5- or 10-percent granules, were applied at the rate of 34 mg. of active ingredient per container. If the 6-inch diameter of the container is considered to be equivalent to 6 inches of a row placed 40 inches from adjacent rows, this dose would approximate 2.0 lbs. per acre.

2/ Numbers in parentheses refer to literature cited.

The sidedress applications of granules in the field were made to establish cotton plants, growing in Lufkin fine sandy loam soil, which were just beginning to fruit. The test compounds were applied to single-row plots, 10 ft. long. Each treatment was replicated four times. The compounds, formulated as 5- or 10-percent granules, were applied at the rate of 2.0 lbs. of active ingredient per acre in two bands, one on each side of the drill row. Each band was placed 6 inches from the row, and 4 to 6 inches deep. The cotton was furrow-irrigated immediately after application.

Results

LD-50 values indicate that most of the experimental compounds tested are similar in toxicity when applied topically to the boll weevil, although CL-47031 was considerably less toxic than the other compounds tested (table 1). Little difference was detected between the experimental compounds when they were applied in a lanolin paste to the stem of cotton plants (table 2). Following application of granules in the seed furrow at planting, CL-47031 and UC-21149 produced greater boll weevil mortalities than NIA-10242 and phorate (table 3). However, no difference was detected with aphid bioassay. Sidedress applications of CL-47031 and UC-21149 to plants in the greenhouse gave higher kills of boll weevils than the other compounds (table 4). The same compounds were among the better compounds as measured by aphid and spider mite bioassay, but differences were not as great as with the boll weevil bioassay (table 4). Sidedress applications of UC-21149 and CL-47031 in the field were superior in boll weevil, aphid, and spider mite control over the other compounds (table 5), and UC-21149 appeared to be slightly better than CL-47031. Soil applications in the greenhouse were considerably more effective than in the field.

Summary

Five experimental compounds, Bayer 30237, Bayer 30554, CL-47031, NIA-10242, and UC-21149, were evaluated as systemic insecticides against the boll weevil, cotton aphid, and carmine spider mite in the laboratory, greenhouse, and field. When all methods of application were considered, UC-21149 and CL-47031 were the most promising against these pests. UC-21149 was slightly better than CL-47031 under field conditions.

Literature Cited

(1) Bull, D. L., D. A. Lindquist, and V. C. House. 1964. Laboratory and greenhouse experiments with a new series of systemic insecticides. J. Econ. Entomol. 57:112-16.

(2) Ridgway, R. L., D. A. Lindquist, and D. L. Bull. 1965. Effect of method of application on uptake of Di-Syston by the cotton plant. J. Econ. Entomol. (In Press)

(3) Ridgway, R. L., L. J. Gorzycki, and D. A. Lindquist. 1965. Evaluation of systemic insecticides for cotton insect control. J. Econ. Entomol. (In Press)

Table 1.--The relative toxicity of several experimental compounds to the boll weevil following topical application.

Compound	LD-50		Slope of regression line	
	µg/insect	95% confidence limits	Slope	95% confidene limits
Bayer 30237	0.119	0.111-0.125	5.47	4.74-6.45
Bayer 30554	0.218	0.204-0.233	4.35	3.73-5.22
NIA-10242	0.107	0.095-0.120	3.29	2.68-4.26
CL-47031	0.415	0.364-0.472	2.56	2.06-3.51
UC-21149	0.092	0.083-0.101	3.38	2.69-4.54

Table 2.--Systemic activity against boll weevils, spider mites, and aphids, of insecticides applied to stems of cotton plants in the 6- to 8-leaf stage at the rate of 2 mg. per plant in a lanolin paste.

Compound	Percent net mortality in a leaf bioassay at indicated days after treatment					
	2	7	14	21	28	Mean a/
	Boll weevils					
Bayer 30237	43	80	83	33	14	51
Bayer 30554	70	73	56	43	29	54
CL-47031	53	67	53	56	10	48
UC-21149	70	47	56	60	14	49
	Spider mites					
Bayer 30237	100	100	-	58	32	72
Bayer 30554	100	100	-	50	32	70
CL-47031	100	100	-	70	15	71
UC-21149	100	100	-	54	40	74
	Aphids					
Bayer 30237	100	100	-	100	93	98
Bayer 30554	100	100	-	100	100	100
CL-47031	100	100	-	76	72	87
UC-21149	100	100	-	100	100	100

a/ No significant differences were detected between materials according to Duncan's multiple range test at the 5-percent level.

Table 3.--Systemic activity of compounds applied in the furrow at planting in small plot tests against the boll weevil and cotton aphid. Insecticide granules were applied at the rate of 1 lb. of toxicant per acre.

Compound	Percent net mortality of boll weevils and percent reduction of aphids at indicated weeks after planting						
	2	3	4	5	6	7	Mean[a]
	Boll weevils						
CL-47031	100	86	20	17	-	-	55 a
UC-21149	68	82	83	0	-	-	58 a
NIA-10242	58	6	17	0	-	-	20 b
Phorate	82	31	27	0	-	-	35 b
Check (actual mortality)	3	3	0	7	-	-	3 c
	Aphids						
CL-47031	-	100	86	80	62	49	75 a
UC-21149	-	100	100	100	60	37	79 a
NIA-10242	-	75	75	100	80	45	75 a
Phorate	-	100	100	48	60	33	68 a

[a] Means followed by the same letter are not significantly different according to Duncan's multiple range test at the 5-percent level.

Table 4.--Systemic activity of compounds applied as a sidedress in the greenhouse to cotton plants in the 6- to 8-leaf stage at the rate of 2.0 lbs. per acre (34 mg. per pot).

Compound	Percent net mortality of boll weevils and percent reduction of aphids and mites at indicated days after application						
	2	7	14	21	28	42	Mean[a]
	Boll weevils						
CL-47031	-	77	100	70	0	-	62 a
Bayer 30237	-	0	25	10	0	-	9 d
Bayer 30554	-	41	84	72	0	-	49 b
NIA-10242	-	15	53	28	0	-	24 c
UC-21149	-	89	100	55	13	-	64 a
Phorate	-	3	62	28	0	-	23 c
Check (actual mortality)	-	0	0	0	0	-	-
	Spider mites						
CL-47031	-	100	100	-	100	83	96 a
Bayer 30237	-	74	65	-	56	16	53 c
Bayer 30554	-	100	100	-	93	77	92 ab
NIA-10242	-	90	100	-	59	80	82 b
UC-21149	-	100	87	-	95	62	86 ab
Phorate	-	60	95	-	100	92	87 ab

Continued:

Table 4.--Continued.

Compound	Percent net mortality of boll weevils and percent reduction of aphids and mites at indicated days after application						
	2	7	14	21	28	42	Mean[a]
	Aphids						
CL-47031	100	100	100	65	-	-	91 a
Bayer 30237	34	50	47	100	-	-	58 b
Bayer 30554	93	99	100	100	-	-	98 a
NIA-10242	100	100	100	100	-	-	100 a
UC-21149	100	100	100	100	-	-	100 a
Phorate	4	53	88	100	-	-	61 b

[a] Means followed by the same letter are not significantly different according to Duncan's multiple range test at the 5-percent level.

Table 5.--Systemic activity of insecticides applied as sidedressings at the rate of 2 lbs. actual insecticide per acre in small-plot field tests.

Compound	Percent net mortality of boll weevils and percent reduction of aphids and mites at indicated weeks after planting						
	1	2	3	4	5	6	Mean[a]
	Boll weevils						
Bayer 30237	0	3	6	0	-	-	2 b
Bayer 30554	30	0	3	0	-	-	8 b
CL-47031	90	37	26	0	-	-	38 a
UC-21149	87	37	6	0	-	-	32 a
Phorate	3	0	0	6	-	-	2 b
Check (actual mortality)	0	3	0	3	-	-	2 b
	Spider mites						
Bayer 30237	0	48	24	13	-	0	17 c
Bayer 30554	39	22	9	31	-	0	20 c
CL-47031	100	43	36	29	-	0	42 b
UC-21149	90	94	84	41	-	10	64 a
Phorate	0	42	43	0	-	0	17 c
	Aphids						
Bayer 30237	37	33	39	0	0	-	22 d
Bayer 30554	100	40	59	85	27	-	62 c
CL-47031	100	92	95	60	36	-	77 b
UC-21149	100	100	100	100	100	-	100 a
Phorate	90	72	77	39	0	-	56 c

[a] Means followed by the same letter are not significantly different according to Duncan's multiple range test at the 5-percent level.

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